DEC STD 067-5 Electrostatic-Sensitive Devices: Related Materials and Products

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ABSTRACT: This document defines the use of electrostatic discharge (ESD) related materials and products in specific applications, including requirements and recommendations for flooring, instrumentation, personnel, and the work area.

APPLICABILITY: This document is mandatory for all personnel who select, procure, install, or survey ESD related materials and products in Digital owned facilities, external manufacturing, or repair sites. It also applies to Original Equipment Manufacturers (OEM).

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to inform Digital personnel about ESD materials and products. It discusses the use of ESD materials and products and provides technical parameters. The document references specific applications as needed. It is intended for those individuals who select, procure, install, or survey ESD protective materials and products.

1.2 SCOPE

This document discusses the attributes of available ESD materials and products and defines requirements for specific environments.

1.3 RESPONSIBILITIES

It is the responsibility of all individuals involved in selecting, procuring, installing, surveying, or calibrating ESD materials and products to know and understand these products. It is the responsibility of the EOS/ESD (Electrical Overstress/Electrostatic Discharge) Control Engineering group to maintain and update the Recommended Product List and Qualified Product List. These lists are available worldwide through Digital's VTX system.

EOS/ESD Control Engineering shall maintain this document and aid in the implementation of its procedures.

2 FLOORING

The following products are to be used in areas where electrostatic sensitive devices or products are handled, worked on, or have no protective packaging. These areas include office environments but not cafeterias, general warehouses, or toilet areas.

2.1 CARPETING

The computer industry requires quality, static-dissipative carpeting. Carpeting manufactured with carbon-suffused nylon or silver-coated nylon is the most effective in controlling static in engineering and office environments.

To test carpet samples, use the following procedure.

1. Wash and rinse the samples thoroughly to eliminate additives.
2. Measure the resistance for ESD control.
   - Resistance must be between 1e+6 and 9e+9 ohms when measured from any point on the carpet to ground. The probe used in this measurement is described in the American National Standard Institute/National Fire Protection Association (ANSI /NFPA) 99, *National Electric Code 1987 Handbook,* Method 56-A.
   - The output voltage of the meter must be 100 volts ± 5 volts.
3. Triboelectric generation must be no greater than 1 KV.
4. Static decay must be 5 KV to less than 50 volts in less than 2 seconds.

2.2 CONDUCTIVE FLOOR FINISH (WAX)

In areas where conventional vinyl tile or an insulative floor has been installed, conductive wax must be applied to provide a path to drain electrostatic charges. Once applied, conductive wax lasts approximately 6 months, if maintained according to the manufacturer's instructions. After this period, the wax must be stripped and reapplied to ensure proper electrostatic control.

Once the wax is applied and allowed to dry, the resistance to ground must be measured as described in subhead 2.1. The following measurements must be achieved.

- The proper resistance for the wax must be between 1e+6 and 1e+9 ohms.
- The electrostatic decay must be from 3 KV to less than 50 volts in less than 0.1 seconds.

The disadvantages of using a conductive wax are cost and maintenance. A gallon of wax costs approximately $40.00 to $45.00 U.S. Dollars (USD). Annually, the total cost of maintenance (including labor) for a standard vinyl floor is approximately $3.00 USD a square foot. Due to this cost, vinyl conductive tile is no longer recommended. Refer to subhead 2.4 for further information.

2.3 DECKING AND MATS

Interlocking static-dissipating decking or antifatigue mats are required in areas that change frequently in size, configuration, or location. An insulative decking must be used in areas where high voltages are present, such as Hipot or power supply manufacturing or repair areas. Components and board products must not be left unprotected in these areas.

Static-dissipating decking or antifatigue mats must be properly grounded as follows.

- On a nonconducting floor, grounding requires a 1 megohm resistor in line to an earth ground.
- On a conducting floor, grounding is not required when the main flooring is already properly grounded.
- Resistance to ground must be between 1e+6 and 1e+9 ohms and must be measured as described in subhead 2.1.
- Electrostatic decay must be from 3 KV to less than 50 volts in less than 0.1 seconds.

2.4 TILE

Digital facilities worldwide have used vinyl conducting tile or static-dissipating rubberized tiles. Vinyl conductive tile is constructed with carbon laced throughout the individual tile; these tiles are linked together using a two part conductive adhesive. This product provides excellent static protection. Experience has shown that materials and maintenance are costly. Refer to subhead 2.2 for further information.

Static-dissipating rubberized tiles are engineered to provide uniform point-to-ground resistance throughout an installation. Maintenance is less costly than vinyl conductive tile, but overall maintenance must be considered when selecting static-control flooring.

For ground verification, use a megohmmeter for point-to-ground testing. The probe must be an NFPA, or equivalent, as described in ANSI/NFPA 99, *National Electric Code 1987 Handbook*, Chapter 12, Section 4.1.3.8. The output voltage of the megohmmeter must be 100 volts.

NOTE

A standard ohm meter cannot read in the ranges needed.

Follow this procedure for point-to-ground testing.

1. Attach the negative lead to a known good earth ground and the positive lead to the probe.
2. Apply 100 volts.
3. Record the results. The resistance to ground must be no less than 250 Kohms and no greater than 1 gigohm.

Most static-dissipating, rubberized tiles are blended and molded to form a one piece, one color effect. This tile is laid down with a conductive adhesive and usually has a low-end resistance between 100 megohms and 10 gigohms point-to-ground.

2.5 POURED EPOXY

Poured epoxy flooring is new to the static control industry. Testing has proved that these floors provide pinpoint resistance-to-ground (controlled resistance), are more durable than previous products, and are less expensive to maintain. Maintenance is the same as for a sealed concrete floor—a regular sweep and damp mop. Poured epoxy floors maintain their appearance even in areas where industrial fork-truck traffic and chemical spills occur.

3 INSTRUMENTATION

3.1 STATIC FIELD METERS (SFM)

Charge readings on static field meters vary greatly between manufacturers. Some error is attributed to the clarity of the manufacturer's instructions. Consider the ease of operation and the intended use as criteria for selection of an SFM. If the meter will be used for random checks, or to determine if ESD charges are present, a small meter will suffice. If the job requires more exact readings, such as laboratory work, a sophisticated unit that allows calibration will be needed.

3.2 ION CURRENT METERS

Ion current meters detect imbalances in tabletop ionizers. Most ionizers have a calibration or balancing screw designed to facilitate corrective maintenance. These meters read the output in nano amps for both the positive and the negative phase. When checking an ionizer, these phases should be as close to equal as possible. An imbalance in an ionizer causes a net positive or negative charge within the area it controls. Ionizers must be calibrated and cleaned quarterly. Refer to subhead 5.6 for detailed maintenance information.

3.3 MEGOHMMETERS

A megohmmeter reads resistance from point-to-ground or from point-to-point on hard or soft tabletop material, or on permanent or temporary ESD flooring. It also reads surface resistance when used with a concentric probe. For the concentric ring design, the surface resistivity is a function of the ratio between the inner diameter of an outer ring electrode (large) and the outer diameter of an inner ring electrode (small). This type of probe requires a multiplier to derive the true surface resistivity. The range of this meter must be from approximately 10 K ohms to 100 gigohms and output voltage must be 100 volts.

NOTE

A surface probe is more expensive than a resistance meter, therefore, a resistance meter is preferred.

3.4 SURFACE RESISTIVITY METERS

Surface resistivity meters measure surface resistivity in ohms per square. The probe for this meter is usually two parallel strips with the length of each strip equal to the width of separation, hence ohms per square. The value in ohms per square is independent of the size of the square and the thickness of the surface film. Ohms per square can be measured with a concentric probe as explained in subhead 3.3; however, due to the design, the inner surface cannot be equal to the outer surface. A multiplier must be used. Surface resistivity readings help to characterize ESD materials but do not guarantee a material's ability to prevent damage from ESD. These meters must have an output voltage of 100 volts and a resistivity range of 1000 ohms up to 1000 gigohms.

4 PERSONNEL

4.1 HEEL AND TOE STRAPS

A pair of heel or toe straps plays an important role in ESD control, allowing personnel to move freely without a wrist strap in an ESD controlled area with static-dissipative flooring. These products vary greatly between manufacturers. Heel and toe straps must have an in-line resistor of 1 megohm installed for personnel safety. There are two disadvantages to heel or toe straps:

1. A pair of heel or toe straps costs approximately $15.00 USD. In a manufacturing facility, the average use is three pairs per person per month. A pair of static-dissipative shoes costs approximately $45.00 USD and lasts between 6 and 12 months.
2. The straps tend to catch on things in a work area, and for this reason are a hazard.

Heel or toe straps are recommended only for visitors, temporary (short-term) personnel, personnel waiting for ESD shoes, and employees with foot problems that prevent wearing the shoes. Use the following recommendations for heel or toe straps.

- Two straps must be worn, one on each shoe.
- When these straps become frayed, ripped, or cut, they must be discarded and replaced. Refer to subhead 4.2 for information about proper maintenance for product compliance.
- Prior to entering any ESD controlled area, these straps must be checked using a footwear tester. Refer to subhead 6.2.

- The resistance to ground must not be less than 1 megohm or greater than 10 megohms.

4.2 STATIC-DISSIPATIVE SHOES

The preferred method for controlling static electricity is with static-dissipative shoes, with or without safety toes, used in conjunction with ESD protective flooring.

All ESD footwear (shoes, heel or toe straps) must be checked daily using a footwear tester prior to entering an ESD protected work area. The approved resistance range for ESD footwear must be from 1 megohm to 1 gigahom. For further information refer to subhead 6.2.

4.3 GARMENTS

ESD protective garments shield the static electricity fields that exist on an employee's clothing by forming a Faraday cage around the person. All ESD protective garments must meet the following conditions.

- Garments must contain carbon suffused nylon, except in clean room applications where garments must contain silver coated nylon.
- Steel fibers must not be used in these garments.
- The fiber used must be uniformly distributed throughout the garment.
- Washing must occur on a weekly basis or as recommended by the manufacturer. The life of ESD garments is between 50 and 75 washings.
- Biannual testing must be done to ensure that the product functions properly. This testing must be in compliance with the EOS/ESD Standard #2, *Standard for Protection of Electrostatic Discharge Susceptible Items: Personnel Garments*.

Consider comfort when selecting protective garments. A close knit weave may cause excessive perspiration and discomfort in manufacturing environments.

4.4 WRIST STRAPS

When selecting wrist straps use the following criteria.

- Carbon-suffused nylon or silver-coated nylon must be the conductive mechanism within the wrist band.
- The band must be made of a comfortable, adjustable, hypoallergenic material.
- The ends must be attached with a nickel or stainless steel pad within the clasp.
- Clean rooms should use the "Twist-o-Flex" or all-metal band. All other applications must use an elastic band.
- The cord must be 10 feet long to allow freedom of movement at the work station or system.
- Wrist straps must contain a 1/4 watt, 1 megohm resistor within the cord or wrist band.
- The cord must be stress-relieved at both ends for extended wear.

When reordering wrist straps from a new supplier, order the same snap set configuration as the original strap to ensure compatibility.

5 ESD WORK AREA

5.1 CHAIRS

When selecting chairs use the following criteria.

- Chairs used in production and prototype engineering or any other ESD controlled environment must have a resistivity in the static dissipative range.
- ESD seating must have a drain path from seat back to seat to wheels with at least 1 megohm resistance from all parts to ground. It is imperative that the drain path include the wheels because drag chains do not consistently provide a good path to ground.
- The wheels must be of a conductive hard rubber or metal.
- If the seat and seat back are of textile material, the conductive fiber must be either carbon-suffused nylon or silver-coated nylon and have at least a 2% conductive fiber content.
- For clean room applications, vinyl based covers must be permanently treated to provide a resistance greater than 10 megohms and less than 10 gigohms.

5.2 CONDUCTIVE AND STATIC-DISSIPATIVE TOTES, BINS, AND CASES

Totes, bins, and cases store or transport electronic components. These conductive containers are usually made from a blow-moldable, plastic material that provide shielding from harmful ESD and electrostatic fields. Static-dissipative products provide resistance between 1 megohm and 100 gigohms.

Dissipative materials are more expensive than conductive materials, therefore, conductive materials are preferred in all situations except clean rooms. To prevent clean room contamination by conductive materials sloughing carbon additives, static-dissipative materials must be used.

5.3 GROUNDED SOLDER STATIONS AND ACCESSORIES

Wherever electronic components are soldered in place, grounded-tip soldering irons must be used. If these fields are left unchecked, immediate or latent failure to the component can result. DOD-STD-2000-1B, *Military Standard Soldering Technology* requires soldering iron tips to have no more than 2 mV RMS. All accessories used around soldering areas must be either static-dissipative or non-electrostatic generating.

5.4 HARD BENCH LAMINATES

Two types of hard bench laminates are available. One is a static-dissipative, buried-layer material consisting of a paper backing, a conductive sheet, and a hard surface (usually a finely crushed stone material). This type of laminate acts as a capacitor and causes charge retention to voltage levels of 500 to 1000 volts which can induce failures in electronic components. The laminate materials have a resistive range from 100 megohms to 10 gigohms.

The second type of hard laminate is a volume conductive material. This laminate is equally conductive from top to bottom and is not a layered product. The resistive range for these products is from 100 K ohms to 90 megohms. A volume conductive laminate is recommended.

All hard laminate tops must be grounded via electrical ground with 18 gauge or heavier wire.

5.5 SOFT BENCH MATS

Soft bench mats are recommended in most workbench applications. They provide good ESD control and a comfortable work surface. When choosing a soft mat material, select a homogeneous (volume resistive) material. Some manufacturers produce a three-layer product with a conductive scrim; however, the scrim layer products are inconsistent in product performance and are not recommended.

When choosing benchtop materials, consider the type of work to be performed at that station. If soldering or hot air systems are planned, materials that will withstand temperatures greater than 400 degrees F are recommended. The resistivity of these materials must be between 1 megohm and 10 gigohms (resistance to ground). Electrostatic decay must be 3 KV to less than 50 volts in less than 1 second and grounding must be as described in subhead 5.4 if the mat is to be used on non-ESD tabletops.

5.6 IONIZERS (BENCH AND ROOM)

Ionization is the most widely used method of generating ions and is referred to as High Voltage Corona Discharge. If a high intensity electrical field is produced at a point, the air becomes ionized. As these ions are propelled toward a charged object, the object will attract the ions of opposite polarity and repel those of like polarity. As electrons are given up or captured by the object, its charge is neutralized through recombination. As long as the ion supply remains balanced, the object will not experience a charge build-up.

Three techniques can be used to generate ions: high voltage ac, pulsed dc, and steady-state dc.

In a high voltage ac system, high voltage is applied to the point using a 60 Hz sine wave. Because the polarity of the point changes each 1/120 of a second, a high velocity air stream is required to propel the ions clear of the point. Newly generated ions are quickly reversed and never reach an object to be neutralized. This system is usually found as a benchtop ionizer.

Alternately pulsed dc systems tend to overcome the limitation of high voltage ac by allowing time between polarity reversals for the ions to escape. However, this system allows the ions to reach the object in alternating waves of positive and negative ions, which can cause an object to have alternating charge build-up exceeding the damage level.

Steady-state or simultaneous-pulsed dc systems can overcome alternating charge build-up with a stream of constantly balanced ions to the object. Since the charged ions are themselves attempting to become neutralized, a higher recombination rate exists with this system. Research proves that the increased recombination can be overcome through optimum design of the system. Such a system is highly recommended for clean rooms or laminar flow hoods.

Ionizers must be maintained on a quarterly basis, or more frequently when required by the manufacturer. The balance of positive to negative ions must be checked regularly; refer to subhead 3.2 for further information about ion current meters.

A fourth and less common way of producing ions is through the use of a nuclear isotope, Polonium 210, which produces alpha particles. Although product literature states that this material is not a health hazard, it is under the control of the Nuclear Regulatory Commission and certain liabilities must be assumed by Digital. Nuclear ionization may be used only when no other alternative is available.

5.7 STATIC-DISSIPATIVE RUBBER AND VINYLS

Static-dissipative mats are recommended for ESD workstation surfaces. The static-dissipative rubber is preferred in areas where solder irons and hot air machines are used. This material wears well and is resistive to temperatures up to 400 degrees F. Static-dissipative vinyls may be used in general work areas; however, they are not to be used in areas where high temperature products are used. Vinyls are frequently cut or torn and usually need to be replaced within a year.

6 MONITORS AND TESTERS

6.1 GROUND MONITORS

Ground monitoring systems verify proper electrostatic grounding for work surfaces, personnel, and soldering equipment. Some systems employ audible and visual alarms while other systems employ only one of the two alarms. Monitoring systems vary in price from $30 to $400 USD. The choice of a monitor depends on the production environment and the type of work performed.

6.2 ESD SHOE AND FOOT STRAP TESTERS

A shoe and foot strap tester verifies proper grounding for personnel working in areas where conductive or static-dissipative flooring is used. When selecting shoe and foot strap testers, use the following criteria.

- The preferred resistance range should be no less than 1 megohm and must not be greater than 1 gigohm.
- Testers must be easy to use and calibrate.

Testers must be used daily prior to entering a ESD controlled area and instructions must be posted at the tester. Testers must be calibrated quarterly.

6.3 WRIST STRAP TESTERS

Follow these guidelines if wrist straps are used.

- Wrist strap testers must be conveniently located throughout the ESD protected area.
- Testers must have a resistance range between 1 megohm and 10 megohms and be simple to use.
- Calibration must occur quarterly.
- Personnel using wrist straps must test them daily.
- Instructions on the use of wrist straps must be posted for all personnel.

7 MISCELLANEOUS

7.1 TOPICAL ANTISTATIC SOLUTIONS

A topical antistatic solution must be used on materials that tribocharge greater than 50 volts and cannot be removed or replaced in an ESD protected area. These solutions must be nontoxic by oral ingestion, inhalation, or dermal application. Frequency of application will depend on such things as temperature, humidity, and contact with other materials. Under normal operations, a weekly application is sufficient.

7.2 CONDUCTIVE RUBBER

Conductive rubber is a very versatile material. In the form of ribbed rubber, the material is used as an anti-slip, anti-fatigue, conductive flooring and proper grounding is essential. For further information refer to subhead 5.4. Ribbed rubber is manufactured with the addition of a carbon powder that reduces the resistance range to less than 1 megohm. The wiping action of the ribs cleans the bottom of the shoe or foot strap and assures clean contact. Contamination or small particles settle in the ribbed grooves and can be vacuumed or swept away. The ribbed rubber material may prevent damage to the benchtop.

7.3 CONDUCTIVE PVC AND ACRYLICS

Conductive polyvinyl chlorides (PVC) and acrylics were developed to replace existing ESD safety guards. These materials are manufactured with a fine electrostatic-dissipating coating that can be washed off with acetones. Facilities may consider using acrylic over PVC due to hazardous outgassing of PVC products in case of fire. It is recommended that local regulations be checked before using PVCs extensively. The resistance range of these products is usually between 10 megohms and 1 gigohm.

7.4 FIELD SERVICE KITS

Field service kits typically consist of a flat mat with a snap connector. These kits vary in structure. Some consist of one piece of volume resistance material. Other kits consist of one piece of double sided material: one side is conductive, and the other side is either static-dissipative or antistatic. Field service kits should meet the following criteria.

- Snap connections must be compatible with existing Digital snap configurations.
- The snap system must be the stackable type.
- The cord for the wrist strap must be 10 feet long, allowing personnel easy movement to and from the field service kit.
- The wrist strap must be made of a comfortable, adjustable material.
- The conductive material must either be of the carbon or silver type.

For further information refer to subhead 4.4.

7.5 SHROUDS AND COVERINGS

Shrouds and covers used within ESD protected work areas must be non-electrostatic generating. They may either be a dissipating material or a topically treated material. When covering machinery, microscopes, or other types of equipment, grounding cannot always be accomplished. The non-electrostatic generating or static-dissipative material used must be of the permanent type that is not humidity dependent and nonoutgassing. Outgassing can cause problems such as film contamination on microscope lenses.

7.6 ADHESIVE TAPES

Adhesive tapes used in any ESD protected areas must be conductive, static-dissipative, or non-electrostatic generating. The type of tape used in the work area depends on the application or environment. If the process or end result of the process involves passing current or data signals, only non-electrostatic generating adhesive tapes can be used.

7.7 VACUUM CLEANERS

Vacuum cleaners are used primarily by Field Service to clean around systems and system modules. Normally the wands, brushes, hoses, and bodies of these vacuum cleaners will produce charges large enough to induce charge through field induction. Vacuum cleaners, attachments, and hoses must be made of static-dissipative materials.

APPENDIX A

REFERENCED DOCUMENTS

A.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00067-03	*DEC STD 067-3 Electrostatic-Sensitive Devices: In Manufacturing Facilities (in process)*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

A.2 Other Documents

Number	Document Title
ANSI/NFPA 99	*Health Care Facilities, Section 3-3.6.2: Conductive Flooring, 1987.* *National Electric Code 1987 Handbook, Section 12-4.1.3.8, NFPA, Fourth Edition.* *American National Standard Institute/National Fire Protection Assoc.* *Batterymarch Park* *Quincy, MA 02269*
DOD-STD-2000-1B	*Military Standard Soldering Technology*
EIA-541	*Package Material Standards for ESD-Sensitive Items*
EOS/ESD Standard #2	*Standard for Protection of Electrostatic Discharge Susceptible Items: Personnel Garments, Association Garments Draft Standard, 1987* EOS/ESD Association, Inc. 200 Liberty Plaza Rome, NY 13440

APPENDIX B

RELATED DOCUMENTS

B.1 Related Documents

Number	Document Title
CSA STD C22.2	*No. 0.4-M1982, Bonding and Grounding of Electrical Equipment (Protective Grounding), Section 2.1, December, 1982* *Canadian Standards Association* *178 Rexdale Boulevard* *Rexdale, Ontario Canada* *M9W 1R3*
EOS/ESD	*Association Glossary of Terms, 1987* *EOS/ESD Association, Inc.* *200 Liberty Plaza* *Rome, NY 13440*
UL 84U4	*ESD Grounding System, 1988.* *Underwriter's Laboratory* *Publications Stock* *333 Pfingsten Road* *Northbrook, IL 60062*

GLOSSARY

antistatic: Refers to a material that does not cause triboelectric generation. Although some documentation specifies a resistivity range for these materials, this standard defines the term without adherence to a resistivity range. This is in accordance with internal purchase specifications, and with external standards such as EIA-541, *Package Material Standards for ESD-Sensitive Items*, all ASTM documentation, and EOS/ESD Association standards.

antistatic agent: A chemical compound which, when impregnated or formulated into or topically applied to a primary material or substrate, gives the primary material antistatic properties.

antistatic property: Refers to the prevention of triboelectric charge generation by effectively minimizing the production of a static charge when materials are separated from another surface. .

barrier materials: Materials used to shield ESD sensitive materials from damage caused by ESD.

blooming: Continuous migration of the agent of the antistatic agent to the surface of the material.

buried metal layer: A Faraday shielding metallic layer laminated between two dissipative surfaces.

carbon suffused: Nylon treated with a carbon compound to form conductive fibers.

conductor: A material made of metal or impregnated with metal or carbon particles or other conductive materials, or whose surface has been treated with such materials through a process of lacquering, plating, metalizing, or printing. A conductive material for static control purposes shall have a surface resistivity less than 1e+5 ohms/square or 1e+3 ohm-cm if volume conductive. A conductive material is not necessarily antistatic.

corona: Ionization of the surrounding atmosphere caused by electric potential on a conductor.

corrosivity: Characteristic property of a material that demonstrates its propensity to cause other materials to corrode.

current: A movement or flow of charge; the rate of flow is measured in amperes.

degradation: Product performance is within original parameters specification, but performance has shifted from original measurements.

electrical overstress (EOS): The electrical stressing of items beyond their electrical specifications. Includes ESD, voltage transients, and lightning.

electrically continuous surface: A surface that is electrically conductive in that current can be passed at an applied voltage between any two points on its physical surface.

electrostatic charge: Electrical charge at rest. The electrical charge is due to the transfer of electrons within a body (polarization) or from one body to another.

electrostatic discharge sensitivity: A property which quantifies the materials inherent susceptibility to either catastrophic failure or latent damage when exposed to sources of ESD.

electrostatic discharge (ESD): The transfer of electrical charge between bodies at different electrostatic potentials.

electrostatic field: The region surrounding an electrically charged object in which another electrical charge will experience a force. Quantitatively, it is the voltage gradient between two points at different potentials.

engineering abbreviations:
G (giga) billion or 1e+9
M (mega) million or 1e+6
K (kilo) 1,000 or 1e+3
m (milli) thousandth or 1e-3
u (micro) millionth or 1e-6
n (nano) billionth or 1e-9
t (tera) trillion or 1e+12

engineering notation: A numbering system where exponentials are listed with "e+/-#". For example, 100 is equivalent to 1e+2, 0.0723 is equal to 7.23e-2.

ESD: Electrostatic discharge.

ESD protective: A property of materials capable of one or more of the following: preventing the generation of static electricity, dissipating electrostatic charges over its surface or volume, and /or providing shielding from ESD or electrostatic fields.

ESD simulator: A device capable of generating an ESD wave form for the purpose of testing.

Faraday shield or cage: Also called Faraday screen. A network of wires connected to a common conductor at one end to provide electrostatic shielding without affecting electromagnetic waves. The common conductor is usually grounded.

field attenuation: To reduce the intensity level or field of a static voltage.

ground: A metallic connection with erth to establish zero potential or voltage with respect to ground or earth.

hard ground: Connection to earth ground without series resistance.

humidity dependent: ESD protective material that changes its resistivity and other properties as the ambient humidity level changes.

insulator, electric: A material with surface resistance of greater than 1e+12 and/or a volume resistance of 1e+10.

ion current meter: An instrument used to check the performance of ion generators.

ion: An atom or molecule with either a positive or negative charge.

ionization: The process by which a neutral atom or molecule, such as air, acquires a positive or negative charge.

ionizers: A family of instruments designed to ionize the atmosphere surrounding a sensitive device or area, and used to reduce possible ESD damage due to static charges building in the area. Included in this family are the following types: hood ionizers, pulsed dc, steady state dc, high voltage ac, and nuclear.

isolated conductor: A conductive material isolated from ground by an insulator.

latent failure: A hidden failure that does not result in an immediately detectable defect condition.

magnetic field: A condition of space in the vicinity of a magnet or electric current which manifests itself as a force on magnetic objects within that space.

megohmmeter: An instrument specially designed to read the higher values of resistance, (up to 1e+14 Ohms) and capable of supplying 100 volts across a Device Under Test (DUT).

melamine: Resin used to make decorative hard laminates.

outgassing: Release of a gaseous material from the surface of a material due to environmental conditions.

personnel grounding devices: Includes static-dissipating smocks, static dissipative shoes, wrist grounding straps, toe grounding straps, heel grounding straps and ground connections convenient to the operator.

pink material: A plastic material traditionally manufactured for protecting ESD sensitive materials. Its properties are NOT guaranteed by the color. Pink materials may be tribogenerating, insulative or otherwise nonprotective.

resistance: The characteristic of a material that dictates the amount of current that will pass through the material at a given voltage.

resistivity, volume: The ratio of the dc voltage per unit thickness applied across two electrodes in contact with a sample to the amount of current per unit area passing through the system. Volume resistivity is given in Ohm- centimeters.

resistivity, surface: The ratio of dc voltage to the current that passes across the surface of the system. In this case, the surface consists of a square unit of area. The surface resistivity is the resistance between two opposite sides of a square and is independent of the size of the square or its dimensional units. Surface resistivity is expressed in ohms/square.

resistive range: The range of resistance measured point to ground.

shield, electromagnetic: A screen or other housing placed around devices or circuits to reduce the effects of external electric or internal magnetic fields. See Faraday shield.

shield, electrostatic: A barrier or enclosure that prevents the penetration of an electrostatic field. An electrostatic shield may not offer much protection against electromagnetic fields. See Faraday shield.

silver-coated nylon: Nylon treated with a silver compound to form conductive fibers.

sloughing: Giving off bits and particles of a product.

soft ground: Connection to hard ground through a protective resistor, typically one megohm. See DEC STD 067-3 (in process).

static dissipative: A property of a material having a surface resistivity of at least 1e+5 ohms/square or 1e+3 ohm-cm volume resistivity, but less than 1e+12 ohms/square surface resistivity or 1e+10 ohm-cm volume resistivity.

surfactant: An antistatic agent that is topically applied to the surface of a non-ESD protective material to cut its propensity to tribogenerate or be an insulator.

triboelectric generation: The generation of electrostatic charges when two pieces of material in intimate contact are separated. Substantial generation of static electricity can be caused by contact and separation of two materials or by rubbing two substances together.

voltage: Electromotive force expressed in volts.

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